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Establishing robust lake sediment chronologies: Lessons from U/Th dating the long lake sediment record from Lake Junín, Peru

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Paleoenvironmental interpretations of lacustrine sequences are often limited by our ability to develop accurate age-depth relationships. In this presentation, we discuss our efforts to uranium-thorium (U/Th) date sediments from the ∼100-m-long sediment core extracted from Lake Junín, Perú, a record unprecedented amongst deep lacustrine records in its dependence on U/Th ages throughout its length.

The sediment core is characterized by alternating packages of glaciogenic siliciclastic sediment and authigenic carbonate marl. We applied U/Th dating to ∼180 bulk carbonate marl samples representing the array of carbonate sedimentological facies observed in the core. With this suite of analyses, we developed a framework for evaluating U/Th dates alongside corresponding sedimentological, elemental, and geochemical data to enhance our ability to make "age" interpretations from "dates" calculated from measurements. As a result of this framework, improved sample selection, and recent advances in analytical techniques, the Lake Junín record is the first continuous, U/Th-dated paleolake record spanning multiple glacial-interglacial cycles in the tropical Andes.

The carbonate marls have high uranium concentrations (0.3-4 ppm) and low detrital content, with ratios of radiogenic 230Th to initial 230Th that are 10-20 times greater than sediments from Lake Titicaca (Fritz et al., 2007) and the Great Salt Lake (Balch et al., 2005). These qualities allow us to date these sediments to within ±200-800 years in the Holocene and ±6000-8000 years between 280 and 400 kyr ago (2-sigma range in uncertainty).

We compare all of our U/Th analyses to corresponding radiocarbon dates, high-resolution X-ray fluorescence (XRF) data, elemental ICP-MS data, magnetic susceptibility measurements, sediment carbon data, and sedimentological facies descriptions to evaluate the robustness of a U/Th date for any given sample. Consequently, we also demonstrate the influence of detrital carbonate (eroded limestone bedrock) on U/Th dating.

When combined with radiocarbon ages and relative paleointensity picks, our geochronological results indicate that the Lake Junín record spans ∼7 glacial-interglacial cycles, complementing the long records from Sabana de Bogotá, Lake Titicaca, and local speleothems and making it well-positioned to yield critical insights on past climate changes in South America.